

SECTION 15400

PLUMBING

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

1.2 REFERENCES (Not Applicable)

1.3 SUBMITTALS

Refer to Section 15003, SD-17, 31, 42, 76 and 92.

1.4 GENERAL REQUIREMENTS

The plumbing systems shall be provided as indicated and specified herein and shall include the following:

Water supply system

Waste and vent system

Plumbing fixtures and fittings

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

PART 2 PRODUCTS

2.1 GENERAL

Materials, equipment, and fixtures to be provided shall be the standard catalog products of manufacturers regularly engaged in the manufacture of the products. Materials, equipment, and fixtures shall meet the specified and the detailed requirements, shall be suitable for the installation shown, and shall represent products that have been in satisfactory use at least 2 years. Products not meeting specified requirements will not be accepted.

Where two or more units of the same class are furnished, the units shall be from the same manufacturer and shall be interchangeable. Products shall be new, free from

defects, and of the size, make, type, and quality specified and indicated in the manufacturer's catalog data.

2.2 WATER SUPPLY SYSTEM COMPONENTS

2.2.1 Pipe and Fittings

2.2.1.1 Copper Pipe

Above ground copper tubing shall conform to ASTM B88, Type L (hard-drawn for horizontal and exposed vertical lines, annealed for concealed vertical lines).

Underground copper tubing shall conform to ASTM B88, Type K seamless. No joints shall be permitted in underground copper piping unless specifically approved. Fittings for connection to corporation cocks (or where indicated on the construction drawings) shall be cast bronze, flared type, conforming to ASME B16.26. Underground joints shall be brazed.

Fittings and unions shall be 150 pounds per square inch gage (psig) working steam pressure (wsp), wrought-copper solder joint conforming to ASME B16.22.

Solder shall be acid flux, 95-5 tin-antimony, alloy Sb5, conforming to FS QQ-S-571. Brazing rod shall be classification BCP-5, conforming to AWS A5.8.

2.2.1.2 Plastic Pipe and Fittings

Solvent weld pipe shall be extruded of an improved CPVC virgin pipe compound. Compound shall conform to ASTM D1784, Cell Classification 12454-B, and have a 2,000-pound per square inch (psi) hydrostatic design stress rating. Pipe and fittings shall conform to AWWA C900 or AWWA C901, Schedule 40 or 80 as indicated.

Pipe shall bear the following markings: manufacturer's name, nominal pipe size, schedule or class, pressure rating in psi, and National Sanitation Foundation (NSF) seal of approval. The manufacturer shall also mark the date of extrusion on the pipe.

Solvent cement or rubber-gasket joints for pipe and fittings shall be made as prescribed by the manufacturer.

Fittings shall be PVC Schedule 40 or 80 as specified.

Fittings shall be injection-molded of an improved PVC compound. Fittings shall conform to ASTM D1784, Cell Classification 12454-B.

Tees and ells shall be side gated.

Fittings shall bear the company's name or trademark, material designation, size, applicable iron pipe size (ips) schedule, and NSF seal of approval.

Threaded nipples shall be standard weight Schedule 80 with molded threads.

2.2.1.3 Galvanized Carbon Steel Pipe

Pipe (1/2 inch through 10 inches, and indicated)	AWWA C200, Schedule 40 seamless or electric- resistance welded galvanized steel conforming to ASTM A53, Type E, Grade B (electric resistance where welded) or Type S (seamless)
Fittings (2 inches and under)	150-psig wsp banded galvanized malleable iron screwed, conforming to ASTM A197 and ASME B16.3
Unions (2 inches and under)	300-psig wsp female, screwed, galvanized malleable iron with brass-to-iron seat and ground joint
Fittings* (2-1/2 inches and over)	125-psig wsp cast-iron flanges and flanged fittings, conforming to ASTM A126, Class A and ASME B16.1

Steel flanges shall conform to AWWA C207.

Field welding of steel pipe shall be as specified in AWWA C206.

* The Contractor has the option of using 150-psig wsp banded galvanized malleable iron screwed fittings, conforming to ASTM A197 and ASME B16.3.

2.2.2 Valves and Specialties

2.2.2.1 Gate Valves

Valves shall be designed for a minimum of 150 psi. Valves shall have bell-and-spigot ends or screw joints. Valves smaller than 3 inches shall be all brass and shall conform to MSS SP-80, Type I. Valves 3 inches and larger shall be iron-body, brass-mounted, conforming to AWWA C500.

2.2.2.2 Vacuum and Relief Valves

Vacuum and relief valves shall be size and type to relieve pressure and prevent the formation of a vacuum. Valves shall automatically remove air from the lines when the lines are being filled and admit air into the lines when water is being withdrawn in excess of the inflow.

2.2.2.3 Hose Faucets

Refer to Section 15050, Paragraph 2.2.10.

2.2.2.4 Globe Valves

Valves shall be 125-psi, bronze body, conforming to MSS SP-80. The disk shall be free to swivel on the stem. Composition seating surface disk construction may be substituted for all-metal disk construction. Packing shall be woven asbestos, impregnated with not less than 25 percent, by weight, tetrafluoroethylene resin.

2.2.2.5 Check Valves

Standard check valves in sizes 2 inches and smaller shall be 125-psi swing check conforming to MSS SP-80. Lift checks (lift check horizontal) and 125-psi valves conforming to MSS SP-80, shall be provided.

Check valves in sizes 2-1/2 inches and larger shall be cast iron, bronze trim, swing type. Valve bodies shall be cast iron, conforming to ASTM A126, Class A. Valve ends shall be flanged in conformance with ASME B16.1. Swing-check pin shall be AISI Type 304 or 316, or approved equal corrosion resistant steel. Valves shall have bolted and gasketed covers.

2.2.2.6 Ball Valves

This type must be suitable for water, oil, gas and air service and have a service pressure rating (SPR) of 150 psig for saturated steam.

The body and bonnet shall be ASTM B62 or B61 bronze. All to be bronze or brass, either of which is chrome plated or 316 stainless steel. Stem to be chrome plated bronze or stainless steel. Stem and body seals and ball seats to be reinforced teflon.

Stem shall be blowout proof and externally adjustable to compensate for wear. Valve to be equipped with lever handle which shall indicate position of ball orifice and have

stops for fully closed position. Construction shall be such that power actuator can be used. Ball opening shall be full pipe size.

Valve shall be suitable for flow in either direction and must be leak proof at all pressures up to 150 psig and temperature from -20 degrees F to 350 degrees F in open or shut position.

Valve must be so constructed that ball, seats, seals and stem can be replaced easily without removing valve pipe connections from the line. It must also be possible to place blank-off plate on valve while valve is in service.

Where indicated, provide ball valves of stainless steel construction. All metal parts in contact with the water shall be 316 stainless steel.

2.2.2.7 Butterfly Valves:

Body shall be bronze, cast iron, carbon steel or stainless steel.

Disc shall be ASTM B62 bronze, monel, or 316 stainless steel. The shape of the disc and location of the stem shall be such that in the open position it will be centered in the valve and streamlined to fluid flow.

Stem shall be nickel bronze, monel or 316 stainless steel and be continuous through center of disc with teflon O-ring seals at both places where stem passes through seat. Stem shall also have reinforced teflon bearings or metal bushing with nylon or teflon bearings. Stem diameter shall conform to AWWA Standard C504, Class 125-16.

The disc seat shall be a replaceable, resilient elastomer of ethylene-propylene or Buna-N, compounded for water at temperatures up to 225 degrees F. It must completely line and protect the fluid chamber of the valve without the use of additional gaskets.

Inside diameter of valve must be within 1/8-inch of the inside diameter of ASTM A53 Schedule 40 steel pipe.

The valve must have a service pressure rating (SPR) of 200 psig and must hold bubble tight at a pressure differential of 150 psig.

Valves 2-1/2 through 10 inches shall have lever handle is handle is seven feet or less above standard level. Handle shall have notched holding position at each 10 degrees rotation from fully open to fully closed. Valves over 10 inches shall be worm gear wheel operated.

In air applications, the elastometer shall be compounded for air.

Where indicated, provide ball valves of stainless steel construction. All metal parts in contact with the water shall be 316 stainless steel.

2.2.2.7.1 Butterfly valves shall be one of three styles as indicated:

Wafer style which is suitable for installation between flanges and which has top and bottom guides for standard flange bolts or a body ridge to insure accurate centering between flanges. Seal at flanges shall be "O" rings or by continuation of body lining.

Flanged beds with lugs for making flange connection.

Adjustable horizontal split body construction such as the worcester "Disc-O-Seal" which clamps over and holds the flanges of the pipe connection. The exposed portion of the pipe connections to be suitable for butt weld.

2.2.2.8 Backflow Prevention Devices

Refer to Section 15432.

2.2.2.9 Water Meters

Refer to Section 15432.

2.2.2.10 Corporation Stops

Corporation stops shall have waterworks standard thread on the inlet end, with flanged-joint couplings or wiped joints for connections to goosenecks.

2.2.2.11 Goosenecks

Copper tubing for gooseneck connections shall conform to the applicable requirements of ASTM B88, Type K, annealed.

2.2.2.12 Service Stops

Service stops shall be waterworks ground-key type, oval flowway, T-handle, without drain. Pipe connections shall be suitable for the type of service pipe used. Parts shall be cast red brass having a nominal composition of 85 percent copper, 5 percent tin, 5 percent lead, and 5 percent zinc, with female ips connections designed for a minimum pressure of 200 psi.

2.2.2.13 Valve Boxes

Valve boxes shall be cast iron or concrete, complete with lock-type covers requiring a special wrench for removal. Cast-iron boxes shall be the extension type with screw or slide adjustments and with flared bases.

Concrete boxes shall be constructed in accordance with details indicated on the construction drawings. The word WATER shall be cast in the cover.

Boxes shall be installed over each gate valve. Boxes shall be of such a length as can be adapted, without full extension, to the depth of cover required over the pipe at the valve location. Concrete boxes may be installed only in locations not subjected to traffic.

2.2.2.14 Valve Manholes

Valve manholes shall be constructed in accordance with the designed details.

2.2.2.15 Water-Hammer Arresters

Water-hammer arresters shall be commercially manufactured products consisting of bellows arranged to absorb the energy of pressure waves generated by valve closure in a line in which water is flowing. Arresters shall be nonferrous construction, shall be rated as to capacity, and shall be certified in accordance with PDI WH 201.

2.2.2.16 Wall Hydrants

Wall hydrants shall have brass wall-boxes with nozzles and detachable T-handles and shall be provided with vandalproof type BAT vacuum breakers.

Exterior surfaces shall be chrome-plated.

2.2.3 Storage-Type Water Heaters

Provide water heater of the storage tank type with steam heating coil. Provide tank and water heater of a size recovery rate not less than that shown.

Construct hot water storage tank of with copper-silicon alloy in accordance with QQ-C-591, nickel-copper alloy in accordance with QQ-N-00281 or reinforced copper lined steel. Furnish lining of sheet copper weighing not less than 3 pounds per square foot (.065-inch thick) with integral circumferential reinforcing rings every 12 inches of shell length. Provide tappings, nozzles, and other tank parts coming in contact with water of

the same material as the tank, except furnish copper lined tank with copper silicon couplings, copper lined nozzle and copper silicon manhole cover.

Construct, test and stamp tank in accordance with the latest American Society of Mechanical Engineers Code for Unfired Pressure Vessels. River and calk or weld seams. Design tanks for a working pressure of not less than 125 psig. Furnish the manufacturers' test sheets, certifying that the tests have been satisfactorily made to the Construction Engineer.

Provide tank with cast iron or steel saddles, and supporting frame constructed of steel pipe with standard weight fittings and floor flanges using two bolts for each flange.

Construct heating coil for water heater of 1-1/4-inches O.D. seamless copper tubing having a wall thickness of not less than .065-inch (16 gage). Use a coil concentric U-bends, and be removable from the storage tank as a unit. Use tube sheets and tube supports or spacers of bronze, copper-silicon alloy or nickel-copper alloy. Design coil so as to provide ample space between tubes (not less than 1/4 inch clear) to permit free circulation of water.

Provide a steam connection to the coil with a single-seated dead-end type, self contained temperature regulating valve. Provide an adjustable regulating valve set to maintain the water temperature in the tank at approximately 140 degrees F. Install the sensing element of the regulator in the storage tank as shown of one of the following types: (a) a tube containing a volatile liquid; (b) an expanding tube containing a non-expanding member; (c) a combination of (a) and (b); or (d) an all metal bulb containing an expanding metallic bellows surrounded by a volatile liquid. Regulators must bear the name or trademark of the manufacturer.

Provide the water heater outfit with one pressure relief valve and one temperature relief valve. The capacity of the relief valve shall be not less than maximum heat input of the heater. Provide spring loaded valve, with testing lever, and with pipe connections not smaller than 3/4-inch pipe size.

Furnish pressure relief valve conforming to the requirements of the BPVC "Pressure Vessels," set to relieve at 100 psig. Install on the cold water connection near the pressure gage.

Provide automatic reseating type temperature relief valve conforming to the requirements of ANSI Z21.11, set to relieve at 210 degrees F. and install so that the operating element is within the tank at the top.

Extend the discharge connection from the relief valve with 3/4-inch or larger zinc coated

pipe to discharge over the floor drain.

Provide the hot water tank with a dial thermometer suitable for hot water and having a dial not less than 3-1/2 inches in diameter graduated from 100 to 250 degrees F.

Install a pressure gage graduated to 200 psig on the cold water connection to the water heating outfit, and located between the tank and the check valve. Use stem mounted gage have 3-1/2-inch dial and black japanned iron case in accordance with GG-G-66. Provide the gage connection with a finished brass T-handle stop.

2.2.4 Water Heater, Instantaneous Type

Provide a factory assembled unit on the instantaneous type complete with steel jacketed insulation steam control valve, service valve, relief valve, thermometers, gages and piping required to operate unit in accordance with the drawings and specifications. See schedule for capacity of the unit.

Provide a temperature sensing device that will sense the change in water temperature and flow rate within the heater and regulate the flow of steam through the pneumatic control valves to insure constant leaving hot water within (+/-) 5 degrees F. of the design temperature under all load conditions, including no load. The sensing device operation is accomplished by passing a sample of the incoming water across the device together with a sample of the water within the heater. Upon sensing a change in water temperature the sensing device modulates the steam control valve to maintain the desired water temperature. The sensing device may be located within or exterior to the heater. When installed exterior provide a circulating pump to pass the water sample across the sensing element.

Heat exchanger shall be constructed of either vertical shell and tube design or 3/4" copper "U" bend tubes expanded into a steel tube sheet, steel shall tube supports and with either cast iron or steel head designed for a system operating pressure of 150 psig and ASME stamped. Construct "U" bend tube type in accordance with the Mechanical Standards TEMA Class "C" Heat Exchangers and have the capacity determined in accordance with the data included in the "Thermal Standards and Physical Properties of Fluids" Section of Standards of TEMA Fifth Edition with 1970 Addenda.

Tube internal fluid velocity shall not Exceed 6 fps.

Shell fluid velocity shall not exceed 5 fps.

2.3 SANITARY DRAIN, WASTE, AND VENT SYSTEM (DWV)

2.3.1 DWV Piping

2.3.1.1 Galvanized Steel

Pipe (all sizes)	Schedule 40 seamless or electric-resistance welded galvanized carbon steel, conforming to ASTM A53, Grade A or ASTM A120
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Furnace butt weld pipe is acceptable for sizes less than 2 inches.

Risers (3 inches and larger)	Cast iron DWV
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(smaller than 3 inches)	Galvanized steel, Schedule 40
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Fittings	Galvanized, coated or uncoated, screwed, cast iron, recessed pattern drainage fittings, conforming to ASTM A126
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Long-radius fittings shall be used wherever space permits. Short-turn tees, branches, and ells may be used for vent piping and connections of branch lines to battery fixtures, except wall-hung water closets.

2.3.1.2 Cast-Iron

- a) Bell-and Spigot pipe and Fittings : Soil pipe drain, waste and vent, conforming to ASTM A74; joints shall be caulked and leaded in lines where necessary to provide proper leaktight support and alignment; other wise joints may be two-gasket system type chloroprene, conforming to ASTM C564. Pipe class shall be extra heavy (CISP-DWV-XH).
- b) Hubless Pipe and Fittings : Drain, waste and vent, above ground, conforming to ASTM A 888 or CISPI 301.

Couplings : ASTM C 1277 assembly of metal housing, corrosion-resistant

fasteners, and ASTM C 564 rubber sleeve with integral, center pipe stop.

a) Heavy-Duty, Type 304, stainless steel couplings : ASTM A 666, Type 304, stainless-steel shield ; stainless-steel bands ; sleeve.

1. NPS 1-1/2 to NPS 4 (DN 40 to DN 100) : 3-inch-(76-mm-) wide shield with 4 bands.

2. NPS 5 to NPS 10 (DN 125 to DN 250) : 4-inch-(102-mm-) wide shield with 6 bands.

b) Heavy-Duty, FM-Approved Couplings : ASTM A 666, Tye 304, stainless-steel housing ; stainless-steel bands ; sleeve.

1. NPS 1-1/2 to NPS 4 (DN 40 to DN 100) : 3-inch-(76-mm-) wide housing with 2 bands.

2. NPS 5 to NPS 10 (DN 125 to DN 250) : 4-inch-(102-mm-) wide housing with 2 bands.

2.3.1.3 Copper

Pipe shall be type DWV copper drainage tube, ASTM B306, with cast brass or wrought copper drainage fittings conforming to ASTM B584 and ANSI B16.23.

2.3.1.4 Polyvinylchloride (PVC)

Polyvinylchloride drain, waste, and vent piping-system materials shall be manufactured from Type I normal impact resins in conformance with ASTM D2665 and FS L-P-320 and with ASME B16.12 for applicable dimensions. Material shall be gray and specifically suited for joining socket interfaces into a homogeneous mass by solvent-cement welding.

Fittings shall be molded to produce upon insertion of pipe an interference fit at approximately two-thirds depth of socket. No thread cutting will be permitted.

Vent extensions through the roof shall be extra-heavy type HSCI.

2.3.2 Sanitary Drain Waste and Vent Fixtures

2.3.2.1 Floor Drains (FD)

Refer to Section 15453

2.3.2.2 Cleanouts (CO)

Refer to Section 15453

2.4 SUPPORTING ELEMENTS

Refer to Section 15050

2.4.1 Building Structure Attachments

Refer to Section 15050

2.4.2 Horizontal Pipe Attachments

2.4.2.1 Single Pipes

Piping in sizes through 2-inch ips shall be supported by Type 6 solid malleable-iron pipe rings, except that split-band rings shall be used in sizes up to 1-inch ips.

Piping in sizes through 8-inch ips inclusive shall be supported by Type 1, 3, or 4 attachments.

Type 1 and 6 assemblies shall be used on vapor-sealed insulated piping and shall have an inside diameter approximately one ips larger than the pipe being supported, to provide adequate clearance during pipe movement.

Type 12 devices with double-bolted, angle-iron wall or fixture clips shall be used in pipe chases to support fixture-supply piping.

Type 40 shields shall be used on insulated piping. The area of the supporting surface shall be such that compression deformation of insulated surfaces does not occur. Longitudinal and transverse shield edges shall be rolled away from the insulation.

Type 39A or Type 39B saddles shall be used for pipe guiding.

Spring supports shall be indicated on the construction drawings. SD-31, Complete spring-support data shall be submitted with shop drawings.

2.4.2.2 Parallel Pipes

Refer to Section 15050

2.4.3 Vertical Single Pipe Attachments

Vertical pipe attachments shall be Type 8.

2.4.4 Hanger Rods

Only circular cross-section rod hangers shall be used to connect building-structure attachments to pipe supports. Pipe, straps, or bars of equivalent strength shall be used for hangers only where approved.

2.4.5 Copper Tubing and Pipe Supports

Metal surfaces in contact with copper tubing or pipe shall be copper-plated or plastic-coated.

Support surfaces shall have large contact areas to prevent point loading with consequent cutting. Minimum direct-contact areas shall be equal to commercially available Type I hangers.

2.5 INSULATION

Hot-water-piping insulation shall be fiberglass with factory-applied jacket conforming to ASTM C547.

Composite UL-listed jacket and insulation shall have a Fire-Hazard Classification of flame-spread 25, smoke-developed 50. Wall penetrations shall be sleeved with foamed, flexible insulation, such as Armaflex, or equal, continuous through the sleeve.

The potable hot- and cold-water lines shall be insulated to the extent shown with standard nominal 3/4-inch, foamed, flexible insulation, such as Armaflex, or equal. The insulation shall be slipped onto the pipe prior to making up fittings. Butt joints shall be sealed with adhesive as recommended by the insulation manufacturer. Outdoor insulation shall be coated with an ultraviolet light protective coating recommended by the insulation manufacturer.

For pipe hangers and supports where the insulation rests on the 1-1/4-inch strap of the adjustable clevis pipe hanger, the insulation shall be cut with a brass cork-borer and a number 15 superior grade cork shall be inserted. Seams shall be sealed with suitable adhesive, such as Armstrong 520 adhesive, or equal. The cork shall be centered on the strap. The length of the cork shall be modified to suit the insulation thickness.

The fitting shall be insulated with miter-cut pieces of pipe insulation of the same size as applied to the adjacent pipe. The miter-cut pieces shall be joined with adhesive, the covers slit, snapped over the fittings, and the joints sealed with adhesive.

After the piping system has been installed, tested, and placed in satisfactory operation, the hanger load nut above the clevis shall be firmly tightened to ensure proper hanger performance. A nipple shall be placed over the 1/2-inch-diameter clevis bolt as a spacer to ensure that the lower U-strap will not move in on the bolt and deform or compress the insulation.

2.6 MISCELLANEOUS MATERIALS

2.6.1 Bituminous Coating

Refer to Section 15050

2.6.2 Bolting

Refer to Section 15050

2.6.3 Elastomer Calk

Refer to Section 15050

2.6.4 Escutcheons

Refer to Section 15050

2.6.5 Flashing

Refer to Section 15050

2.6.6 Grout

Refer to Section 15050, Paragraph 2.4.7.

2.6.7 Pipe Thread Compounds

Refer to Section 15050, Paragraph 2.4.8.

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILL

Excavation and backfill operations are to be performed in accordance with Section 02200, "Site Preparation and Earthwork".

3.2 PIPE INSTALLATION

Piping systems shall be fabricated and installed in accordance with the requirements of the following codes and standards except as supplemented and modified by these specifications:

ASME B31.1

MSS SP-69

AWS for applicable materials and procedures not covered herein

Final connections to equipment shall be made with unions or flanges. A union or flange shall be provided every 100 feet of straight run. Unions shall be provided in the line downstream of screwed- and welded-end valves.

Metallic pipe ends shall be reamed before joint connections are made.

Pipe ends shall be reamed before joint connections are made.

Screwed joints shall be made up with tetrafluoroethylene joint compound or tape and not more than three threads shall show after the joint is made up.

Connections between copper and steel pipe or equipment shall be made using dielectric unions or flanges having 175-psi and 210-degree F minimum pressure and temperature ratings, respectively.

Cutting of metallic piping shall be by wheel cutters or other machines designed specifically for that purpose. Electric-arc and oxyacetylene cutting will not be permitted.

Plastic pipe shall be cut with a knife or hand saw. Cuts shall be made square with pipe. Burrs shall be removed by smoothing edges with a knife, file, or sandpaper.

Schedule 40 plastic pipe shall not be threaded.

Joint compounds shall be applied to the male thread only and care shall be exercised to prevent compound from reaching the unthreaded interior of the pipe.

Screwed unions, welded unions, or bolted flanges shall be provided wherever required to permit convenient removal of equipment, valves, and piping accessories from the piping system for maintenance.

The piping systems shall be securely supported with due allowance for thrust forces and thermal expansion and contraction, and shall not be subjected to mechanical, chemical, vibration, or other damage as specified in ASME B31.1.

Field welded joints shall conform to the requirements of the AWS WH, ASME B31.1, and ASME BPV IX.

3.3 VALVES

Refer to Section 15100

3.4 SUPPORTING ELEMENTS INSTALLATION

Refer to Section 15050

3.5 PENETRATIONS

Refer to Section 15050

3.6 SLEEVES

Refer to Section 15050

3.7 ESCUTCHEONS

Refer to Section 15050

3.8 FLASHINGS

Flashings shall be provided at penetrations of building boundaries by mechanical systems and related work.

3.9 UNDERGROUND PIPING INSTALLATION

Prior to being lowered into a trench, piping shall be cleaned, visually inspected for apparent defects, and tapped with a hammer to audibly detect hidden defects.

Suspect cast-ferrous piping shall be further inspected by painting with kerosene on external surfaces to reveal cracks.

Defective materials found shall be distinctly marked using a road-traffic quality yellow paint; defective material shall be promptly removed from the site.

After conduit has been inspected, and not less than 48 hours prior to being lowered into a trench, external surfaces of cast ferrous conduit shall be coated with a compatible bituminous coating for protection against brackish ground water. Application shall be single coat, in accordance with the manufacturer's instructions, to result in a dry-film thickness of not less than 12 mils.

Excavations shall be dry and clear of extraneous materials when pipe is being laid.

Laying of pipe shall begin at the low point of a system. When in final acceptance position, it shall be true to the grades and alignment, with unbroken continuity of invert. Blocking and wedging will not be permitted.

Bell or grooved ends of piping shall point upstream, unless otherwise approved.

Changes in direction shall be made with long sweep fittings unless otherwise approved.

Necessary socket clamping, piers, bases, anchors, and thrust blocking shall be provided. Rods, clamps, and bolting shall be protected with a coating of bitumen.

Underground piping below supported or suspended slabs shall be supported from the slab with a minimum of two supports per length of pipe. Supports shall be protected with a coating of bitumen.

On excavations that occur near and below building footings, the backfilling material shall consist of 2,000-psi cured compressive-strength concrete poured or pressure grouted up to the level of the footing.

Vertical downspouts; soil, waste, and vent stacks; water risers; and similar work shall be properly supported on approved piers at the base and provided with approved structural supports attached to building construction.

When PVC pipe is installed in a trench, single conductor No. 14 AWG wire with Type TW insulation shall be installed above the pipe to facilitate pipe location.

3.10 TESTS

Plumbing systems shall be tested to prove tightness of piping and connections and proper operation of equipment and fixtures.

Hydrostatic tests shall be performed by completely filling the piping system with water and eliminating accumulation of air so that any leakage will be immediately apparent on the test gage. Pressure shall be maintained until pipe under test has been examined, but in no case for less than 8 hours. Test gages shall be of sufficient size to readily show any pressure drop.

Hot- and cold-water piping shall be tested hydrostatically under 125 psi pressure for not less than 8 hours with no loss of pressure. Leaks shall be eliminated by replacing the pipe or fitting in question at no additional cost to the Government. Underground hot- and cold-water piping shall be tested before backfilling.

Drainage and venting piping shall be tested before the fixtures are installed. Underground soil and waste piping shall be tested before backfilling. Testing shall be applied to the system in its entirety or in sections.

If the entire system is tested, openings in the pipes shall be tightly closed except the highest opening, and the system shall be filled with water to the point of overflow.

If the system is tested in sections, each opening except the highest opening of the section under test shall be tightly plugged, and each section shall be filled with water and tested with at least a 10-foot head of water. In testing successive sections, at least the upper 10 feet of the next preceding section shall be tested so that each joint or pipe except the uppermost 10 feet of the system has been submitted to a test of at least a 10-foot head of water. The water shall be kept in the system or in the portion under test for at least 2 hours before the inspection starts. The system shall be proved tight at all joints.

3.11 STERILIZATION

Refer to Section 15050

3.12 PLUMBING FIXTURES

Materials, equipment, and fixtures shall be installed as indicated and specified and in accordance with the manufacturer's recommendations.

Installation of plumbing fixtures shall conform to the published or written instructions of the manufacturer for the specific project application, except as otherwise specified herein.

Fixtures shall be clean and free of deleterious material before being installed. Before connecting to water, waste, vent, or trap service, the fixture lines shall be blown out with compressed air. During the progress of construction, open ends of fixtures shall be protected at all times to prevent the admission of foreign matter.

3.13 INSULATION

After tests have been completed and surfaces cleaned, insulation shall be installed on hot-water piping except for chrome-plated brass pipe and other hot-water-exposed supplies to fixtures.

Thickness shall be not less than 3/4 inch for piping 1 inch or less and 1 inch for piping larger than 1 inch.

Valves and fittings shall be insulated with segments of insulation of the same material and thickness as the adjoining pipe insulation.

3.14 CLEANING AND ADJUSTING

At the completion of the work, all parts of the installation shall be thoroughly cleaned. Equipment, including pipes, valves, and fittings, shall be cleaned of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system. Automatic control devices shall be adjusted for proper operation.

*** End of Section ***